

of \$1.72 to a high of \$8.80 per press.<sup>b</sup> Costs of using the baseline product range from \$1.64 to \$3.64 per press. Where costs of the alternative blanket washes exceed the baseline, percentage cost increases range from one percent to 179 percent. Table 7-5 presents a summary of the cost comparisons.

Disposal costs were not considered in this cost comparison because all but one of the printers participating in the performance demonstrations use cloth wipes that are leased from an industrial laundry. Many industrial laundries currently do not distinguish between hazardous and nonhazardous blanket washes when laundering wipes; therefore, it was assumed that there would be no savings in waste handling or processing costs associated with switching to a substitute blanket wash product.

## 7.2 QUALITATIVE DISCUSSION OF BENEFIT/COST ANALYSIS

### 7.2.1 Introduction

Social benefit/cost analysis is a tool used by policy makers to systematically evaluate the impacts to all of *society* resulting from individual decisions. The decision evaluated in this analysis is the choice of a blanket wash product. Printers have certain criteria which they use to evaluate the benefits and costs of alternative blanket cleaners such as price, drying time, flexibility of use for rollers and blankets, propensity to cause blanket swell, etc. A printer might ask what impact their choice of blanket washes will have on operating costs, compliance costs, liability costs, and insurance premiums. This business planning process is unlike social benefit/cost analysis, however, because it approaches the comparison from the standpoint of the individual printing firm and not from the standpoint of *society*. A social benefit/cost analysis seeks to compare the benefits and costs of a given action, considering both the private and external costs and benefits.<sup>c</sup> Therefore, the analysis will consider the impact of the alternative blanket cleaners on operating costs, regulatory costs, and insurance premiums, but will also consider the *external* costs and benefits of the alternative blanket cleaners such as reductions in environmental damage and reductions in the risk of illness for the general public. External costs are not borne by the printer, however; they are true costs to society.

Benefits of the substitute blanket cleaners may include private benefits such as increased profits resulting from improved worker productivity, a reduction in employee sickness, or reduced property and health insurance costs and external benefits such as a reduction in pollutants emitted to the environment or reduced use of natural resources. Costs of the substitute blanket cleaners may include private costs such as higher operating expenses resulting from a higher priced blanket wash and external costs such as an increase in human health risks and ecological damage. Several of the benefit categories considered in this analysis share elements of both private and external costs and benefits. For example, use of the substitute blanket washes may result in energy and natural resource savings. Such a

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<sup>b</sup> Presses are assumed to have four units; therefore, four blankets are washed each time a press is cleaned.

<sup>c</sup> Private costs include any direct costs incurred by the decision-maker and are typically reflected in the firm's balance sheet. In contrast, external costs are incurred by parties other than the primary participants to the transaction. Economists distinguish between private and external costs because each will affect the decision maker differently. Although external costs are real costs to some members of society, they are not incurred by the decision maker and firms do not normally take them into account when making their decisions. A common example of external costs is the electric utility whose emissions are reducing crop yields for the farmer operating downwind. The external costs incurred by the farmer in the form of reduced crop yields are not considered by the utility when deciding how much electricity to produce. The farmer's losses do not appear on the utility's balance sheet.

Table 7-5. Summary of Cost Analysis for Blanket Wash Performance Demonstration

Formula Number	Test Facility	Total cost/wash (Baseline)	Total cost/wash (Alternative)	Total cost/press (Base)	Total cost/press (Alternative)	Total cost/press/shift/year (Base)	Total cost/press/shift/year (Alternative)	Percentage Difference <sup>1</sup>
1	Facility 3	0.55	0.69	2.20	2.76	5,500	6,900	+25
	Facility 6	0.46	0.87	1.84	3.48	4,600	8,700	+89
6	Facility 11	0.70	0.82	2.80	3.28	7,000	8,200	+17
	Facility 15	0.50	0.77	2.00	3.08	5,000	7,700	+54
9	Facility 10	0.91	2.08	3.64	8.32	9,100	20,800	+129
	Facility 15	0.50	0.92	2.00	3.68	5,000	9,200	+84
10	Facility 3	0.55	0.57	2.20	2.28	5,500	5,700	+4
	Facility 4	0.85	2.20	3.40	8.80	8,500	22,000	+159
11	Facility 1	0.59	1.29	2.36	5.16	5,900	12,900	+119
	Facility 2	0.53	0.68	2.12	2.72	5,300	6,800	+28
12	Facility 12	0.81	0.99	3.24	3.96	8,100	9,900	+22
	Facility 13	0.80	0.83	3.20	3.32	8,000	8,300	+4
14	Facility 6	0.46	1.07	1.84	4.28	4,600	10,700	+133
	Facility 16	0.66	0.82	2.64	3.28	6,600	8,200	+24
19	Facility 18	0.62	1.66	2.48	6.64	6,200	16,600	+168
	Facility 19	0.53	0.89	2.12	3.56	5,300	8,900	+68
20	Facility 11	0.70	1.13	2.80	4.52	7,000	11,300	+61
	Facility 12	0.81	1.58	3.24	6.32	8,100	15,800	+95

<sup>1</sup> A positive sign denotes an increase and a negative sign denotes a decrease in the cost when using the alternative blanket cleaner instead of the base product.

Formula Number	Test Facility	Total cost/wash (Base)	Total cost/wash (Alternative)	Total cost/press (Base)	Total cost/press (Alternative)	Total cost/press/shift/year (Base)	Total cost/press/shift/year (Alternative)	Percentage Difference <sup>1</sup>
21	Facility 6	0.46	1.01	1.84	4.04	4,600	10,100	+120
	Facility 17	0.41	0.58	1.64	2.32	4,100	5,800	+41
22	Facility 12	0.81	0.82	3.24	3.28	8,100	8,200	+1
	Facility 13	0.80	1.51	3.20	6.04	8,000	15,100	+89
24	Facility 16	0.66	0.97	2.64	3.88	6,600	9,700	+47
	Facility 17	0.41	0.88	1.64	3.52	4,100	8,800	+115
26	Facility 5	0.55	0.73	2.20	2.92	5,500	7,300	+33
	Facility 15	0.50	0.47	2.00	1.88	5,000	4,700	-6
29	Facility 7	0.57	0.93	2.28	3.72	5,700	9,300	+63
	Facility 8	0.55	0.89	2.20	3.56	5,500	8,900	+62
30	Facility 18	0.62	1.01	2.48	4.04	6,200	10,100	+63
	Facility 19	0.53	0.62	2.12	2.48	5,300	6,200	+17
31	Facility 7	0.57	1.59	2.28	6.36	5,700	15,900	+179
	Facility 8	0.55	0.59	2.20	2.36	5,500	5,900	+7
32	Facility 1	0.59	1.31	2.36	5.24	5,900	13,100	+122
	Facility 5	0.53	0.43	2.12	1.72	5,300	4,300	-19
34	Facility 1	0.59	0.89	2.36	3.56	5,900	8,900	+51
	Facility 19	0.53	0.95	2.12	3.80	5,300	9,500	+79

<sup>1</sup> A positive sign denotes an increase and a negative sign denotes a decrease in the cost when using the alternative blanket cleaner instead of the base product.

Formula Number	Test Facility	Total cost/wash (Base)	Total cost/wash (Alternative)	Total cost/press (Base)	Total cost/press (Alternative)	Total cost/press/shift/year (Base)	Total cost/press/shift/year (Alternative)	Percentage Difference <sup>1</sup>
37	Facility 3	0.55	0.48	2.20	1.92	5,500	4,800	-13
	Facility 4	0.85	0.79	3.40	3.16	8,500	7,900	-7
38	Facility 2	0.53	1.08	2.12	4.32	5,300	10,800	+104
	Facility 4	0.85	1.11	3.40	4.44	8,500	11,100	+31
39	Facility 5	0.55	0.69	2.20	2.76	5,500	6,900	+25
	Facility 8	0.55	0.80	2.20	3.20	5,500	8,000	+45
40	Facility 1	0.59	0.79	2.36	3.16	5,900	7,900	+34
	Facility 10	0.91	0.87	3.64	3.48	9,100	8,700	-4

<sup>1</sup> A positive sign denotes an increase and a negative sign denotes a decrease in the cost when using the alternative blanket cleaner instead of the base product.

The following terms are used throughout the benefit/cost analysis:

**Table 7-6. Glossary of Benefit/Cost Analysis Terms**

<u>Term</u>	<u>Definition</u>
Exposed Population	The estimated number of people from the general public or a specific population group who are exposed to a chemical through wide dispersion of a chemical in the environment (e.g., DDT). A specific population group could be exposed to a chemical due to its physical proximity to a manufacturing facility (e.g., residents who live near a facility using a chemical), use of the chemical or a product containing a chemical, or through other means.
Exposed Worker Population	The estimated number of employees in an industry exposed to the chemical, process and/or technology under consideration. This number may be based on market share data as well as estimations of the number of facilities and the number of employees in each facility associated with the chemical, process, and/or technology under consideration.
Externality	A cost or benefit that involves a third party who is not a part of a market transaction; "a direct effect on another's profit or welfare arising as an incidental by-product of some other person's or firm's legitimate activity" (Mishan, 1976). The term "externality" is a general term which can refer to either <u>external benefits</u> or <u>external costs</u> .
External Benefits	For example, if an educational program results in behavioral changes which reduce the exposure of a population group to a disease, then an external benefit is experienced by those members of the group who did not participate in the educational program. For the example of nonsmokers exposed to second-hand smoke, an external benefit can be said to result when smokers are removed from situations in which they expose nonsmokers to tobacco smoke.
External Costs	For example, if a steel mill emits waste into a river which poisons the fish in a nearby fishery, the fishery experiences an external cost as a consequence of the steel production. Another example of an external cost is the effect of second-hand smoke on nonsmokers.
Human Health Benefits	Reduced health risks to workers in an industry or business as well as to the general public as a result of switching to less toxic or less hazardous chemicals, processes, and/or technologies. An example would be switching to a less volatile organic compound, lessening worker inhalation exposures as well as decreasing the formation of photochemical smog in the ambient air.
Human Health Costs	The cost of adverse human health effects associated with production, consumption, and disposal of a firm's product. An example is respiratory effects from stack emissions, which can be quantified by analyzing the resulting costs of health care and the reduction in life expectancy, as well as the lost wages as a result of being unable to work.
Illness Costs	A financial term referring to the liability and health care insurance costs a company must pay to protect itself against injury or disability to its workers or other affected individuals. These costs are known as illness benefits to the affected individual.

## 7.2 QUALITATIVE DISCUSSION OF BENEFIT/COST ANALYSIS

Indirect Medical Costs	Indirect medical costs associated with a disease or medical condition resulting from exposure to a chemical or product. Examples would be the decreased productivity of patients suffering a disability or death and the value of pain and suffering borne by the afflicted individual and/or family and friends.
Private (Internalized) Costs	The direct costs incurred by industry or consumers in the marketplace. Examples include a firm's cost of raw materials and labor, a firm's costs of complying with environmental regulations, or the cost to a consumer of purchasing a product.
Social Cost	The total cost of an activity that is imposed on society. Social costs are the sum of the private costs and the external costs. Therefore, in the example of the steel mill, social costs of steel production are the sum of all private costs (e.g., raw material and labor costs) and the sum of all external costs (e.g., the costs associated with the poisoned fish).
Social Benefit	The total benefit of an activity that society receives, i.e., the sum of the private benefits and the external benefits. For example, if a new product yields pollution prevention opportunities (e.g., reduced waste in production or consumption of the product), then the total benefit to society of the new product is the sum of the private benefit (value of the product that is reflected in the marketplace) and the external benefit (benefit society receives from reduced waste).
Willingness-to-pay	Estimates used in benefits valuation intended to encompass the full value of avoiding a health or environmental effect. For human health effects, the components of willingness-to-pay include the value of avoiding pain and suffering, impacts on the quality of life, costs of medical treatment, loss of income, and, in the case of mortality, the value of a life.

benefit may result in private benefits in the form of reduced product usage and waste print runs as well as external benefits in the form of reduced consumption of non-renewable resources.

### 7.2.2 Benefit/Cost Methodology

The methodology for conducting a social benefit/cost assessment can be broken down into four general steps: 1) obtain information on the relative performance, human and environmental risk, process safety hazards, and energy and natural resource requirements of the baseline and the alternatives; 2) construct matrices of the data collected; 3) when possible, monetize the values presented within the matrices; and 4) compare the data generated for the alternative and the baseline in order to produce an estimate of net social benefits. Section 7.1 presents the results of the first task by summarizing the performance data, risk data, and energy and natural resource information for the baseline and the alternative blanket washes. In Table 7.5 the data required to make a determination of the relative costs and benefits of switching to an alternative blanket wash are organized according to formulation number, beginning with the baseline. Ideally, the analysis would quantify the social benefits and costs of using the substitute and baseline blanket wash products, allowing identification of the substitute product whose use results in the largest net social benefits. However, because of data limitations and production facility variations, the analysis presents instead a qualitative description of the risks associated with each substitute product compared to the baseline. Benefits derived from a reduction in risk are described and discussed, but not quantified; the information provided can be very useful in the decision making process. A few examples are provided to quantitatively illustrate some of the benefit considerations. Personnel in each individual facility will have to examine the information

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presented, weigh each piece according to facility and community characteristics, and develop an independent choice.

The analysis is further developed in the following sections, beginning in Section 7.2.3 with summaries of the potential risks of the substitute and baseline blanket washes. Section 7.2.4 provides a summary of the financial costs of the baseline and the alternative blanket washes, Section 7.2.5 compares the benefits and costs of using the substitute blanket wash products instead of the baseline wash, and Section 7.2.6 provides an indication of the minimum benefits per affected person that would accrue to society if switching to substitute blanket wash products reduced cases of certain adverse health effects.

**Table 7-7. Costs and Benefits of Baseline and Substitute Blanket Washes**

Formula Number	Private Costs <sup>1</sup>		Private Benefits			External Benefits
	Average Cost/Press	% Change	Worker Risk Trade-offs	Flammability Risk <sup>2</sup>	% VOC	Environmental Risk
Baseline (28)			Low to moderate concern for dermal and inhalation exposure. <sup>4</sup>	High risk	99%	No estimated risk
1	Alternative: 2.76 Baseline: 2.20	+25	Overall concern is low for dermal and inhalation exposure. <sup>4</sup>	Low risk	30%	No estimated risk
	Alternative: 3.48 Baseline: 1.84	+89				
3	Not tested		Concern for dermal exposure and inhalation exposure.	Moderate Risk	91%	Aquatic species risk
4	Not tested		Concern for dermal exposure and very low concern for inhalation exposure.	Moderate Risk	89%	Aquatic species risk
5	Not tested		Concern for dermal exposure and very low concern for inhalation exposure.	Moderate Risk	30%	Aquatic species risk
6	Alternative: 3.28 Baseline: 2.80	+17	Concern for dermal exposure and very low concern for inhalation exposure.	Low risk	47%	Aquatic species risk
	Alternative: 3.08 Baseline: 2.00	+54				
7	Not tested		Concern for dermal exposure and very low concern for inhalation exposure.	Low Risk	36%	Aquatic species risk
8	Not tested		Low concern for dermal exposure and very low concern for inhalation exposure.	Moderate Risk	41%	Aquatic species risk

## 7.2 QUALITATIVE DISCUSSION OF BENEFIT/COST ANALYSIS

Formula Number	Private Costs <sup>1</sup>			Private Benefits			External Benefits
	Average Cost/Press		% Change	Worker Risk Trade-offs	Flammability Risk <sup>2</sup>	% VOC	Environmental Risk
9	Alternative: 8.32	3.64	+129	Very low concern for dermal exposure and no concern for inhalation exposure. <sup>4</sup>	Low risk	10%	Aquatic species risk
	Alternative: 3.68	2.00	+84				
10	Alternative: 2.28	2.20	+4	Very low concern for dermal exposure <sup>3</sup> and no concern for inhalation exposure. <sup>4</sup>	Low risk	2%	No estimated risk
	Alternative: 8.80	3.40	+159				
11	Alternative: 5.16	2.36	+119	Concern for dermal exposure and very low concern for inhalation exposure.	Low risk	61%	Aquatic species risk
	Alternative: 2.72	2.12	+28				
12	Alternative: 3.96	3.24	+22	Concern for dermal exposure and low concern for inhalation exposure. <sup>3</sup>	Moderate risk	20%	No estimated risk
	Alternative: 3.32	3.20	+4				
14	Alternative: 4.28	1.84	+133	Low concern for dermal and inhalation exposure. <sup>3</sup>	Low risk	12%	No estimated risk
	Alternative: 3.28	2.64	+24				
16	Not tested			Concern for dermal	Moderate	99%	No estimated
17	Not tested			Possible concern for dermal	Low Risk	0.6%	Aquatic
19	Alternative: 6.64	2.48	+168	Low concern for dermal and inhalation exposure. <sup>3</sup>	Low risk	22%	No estimated risk
	Alternative: 3.56	2.12	+68				
20	Alternative: 4.52	2.80	+61	Concern for dermal exposure and low concern for inhalation exposure. <sup>3</sup>	Low risk	35%	Aquatic species risk
	Alternative: 6.32	3.24	+95				
21	Alternative: 4.04	1.84	+120	Concern for dermal exposure and very low concern for inhalation exposure.	Moderate risk	47%	No estimated risk
	Alternative: 2.32	1.64	+41				
22	Alternative: 3.28	3.24	+1	Moderate concern for dermal exposure <sup>3</sup> and low concern for inhalation exposure. <sup>4</sup>	Low risk	17%	No estimated risk
	Alternative: 6.04	3.20	+89				



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Formula Number	Private Costs <sup>1</sup>		Private Benefits			External Benefits
	Average Cost/Press	% Change	Worker Risk Trade-offs	Flammability Risk <sup>2</sup>	% VOC	Environmental Risk
23	Not tested		Possible concern for dermal exposure and very low concern for inhalation exposure.	Moderate Risk	6%	No estimated risk
24	Alternative: 3.88 Baseline: 2.64	+47	Concern for dermal exposure and very low concern for inhalation exposure.	Moderate risk	19%	No estimated risk
	Alternative: 3.52 Baseline: 1.64	+115				
25	Not tested		Concern for dermal exposure and very low concern for inhalation exposure.	Low risk	55%	No estimated risk
26	Alternative: 2.92 Baseline: 2.20	+33	Concern for dermal exposure and no concern for inhalation exposure. <sup>4</sup>	Low risk	18%	No estimated risk
	Alternative: 1.88 Baseline: 2.00	-6				
27	Not tested		Concern for dermal exposure and very low concern for inhalation exposure.	Moderate risk	93%	No estimated risk
29	Alternative: 3.72 Baseline: 2.28	+63	Low concern for dermal exposure <sup>3</sup> and no concern for inhalation exposure. <sup>4</sup>	Low risk	30%	No estimated risk
	Alternative: 3.56 Baseline: 2.20	+62				
30	Alternative: 4.04 Baseline: 2.48	+63	Concern for dermal exposure and low concern for inhalation exposure. <sup>3</sup>	Moderate risk	7%	No estimated risk
	Alternative: 2.48 Baseline: 2.12	+17				
31	Alternative: 6.36 Baseline: 2.28	+179	Concern for dermal exposure and low concern for inhalation exposure. <sup>3</sup>	Moderate risk	99%	No estimated risk
	Alternative: 2.36 Baseline: 2.20	+7				
32	Alternative: 5.24 Baseline: 2.36	+122	Low to moderate concern for dermal and inhalation exposure. <sup>3</sup>	Low risk	99%	No estimated risk
	Alternative: 1.72 Baseline: 2.12	-19				
33	Not tested		Concern for dermal exposure and very low concern for inhalation exposure.	Moderate risk	46%	No estimated risk
34	Alternative: 3.56 Baseline: 2.36	+51	Concern for dermal exposure and low concern for inhalation exposure. <sup>3</sup>	Moderate risk	39%	No estimated risk
	Alternative: 3.80 Baseline: 2.12	+79				

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Formula Number	Private Costs <sup>1</sup>		Private Benefits			External Benefits
	Average Cost/Press	% Change	Worker Risk Trade-offs	Flammability Risk <sup>2</sup>	% VOC	Environmental Risk
35	Not tested		Concern for dermal exposure and low concern for inhalation exposure.	Moderate risk	99%	No estimated risk
36	Not tested		Concern for dermal exposure and low concern for inhalation exposure. <sup>3</sup>	Low risk	48%	No estimated risk
37	Alternative: 1.92	-13	Low to moderate concern for dermal exposure and low concern for inhalation exposure. <sup>3</sup>	High risk	14%	No estimated risk
	Baseline: 2.20					
38	Alternative: 3.16	-7	Low to moderate concern for dermal exposure and low concern for inhalation exposure. <sup>3</sup>	Low risk	65%	No estimated risk
	Baseline: 3.40					
39	Alternative: 4.32	+104	Low to moderate concern for dermal exposure and low concern for inhalation exposure. <sup>3</sup>	Low risk	52%	No estimated risk
	Baseline: 2.12					
40	Alternative: 4.44	+31	Low concern for dermal exposure and very low concern for inhalation exposure.	Low risk	52%	Aquatic species risk
	Baseline: 3.40					
39	Alternative: 2.76	+25	Low concern for dermal exposure and very low concern for inhalation exposure.	Low risk	52%	No estimated risk
	Baseline: 2.20					
40	Alternative: 3.20	+45	Concern for dermal exposure and low concern for inhalation exposure. <sup>4</sup>	Low risk	52%	Aquatic species risk
	Baseline: 2.20					
40	Alternative: 3.16	+34	Concern for dermal exposure and low concern for inhalation exposure. <sup>4</sup>	Low risk	52%	Aquatic species risk
	Baseline: 2.36					
40	Alternative: 3.48	-4	Concern for dermal exposure and low concern for inhalation exposure. <sup>4</sup>	Low risk	52%	Aquatic species risk
	Baseline: 3.64					

<sup>1</sup> Cost analysis based upon product performance as determined by the performance demonstration at various testing facilities and pricing submitted by the product supplier. See Chapter 4 for a more in-depth description of the cost analysis and descriptions of the testing facilities.

<sup>2</sup> Flammability risks are defined as follows: 1) High Risk: products with a flash point less than 100°F; 2) Moderate Risk: products with a flash point greater than 100°F but less than 150°F; and Low Risk: products with a flash point greater than 150°F.

<sup>3</sup> Risks for this chemical could not be quantified; therefore, the level of concern for this chemical is based upon a structure-activity analysis.

<sup>4</sup> Risks for this chemical could not be quantified; therefore, the level of concern for this chemical is based solely upon estimated exposure levels.

### 7.2.3 Potential Benefits

The potential social benefits associated with the use of a substitute blanket cleaner versus the baseline wash include: reduced health risks for workers and the general public, reduced risk of fire and explosion due to lower flammability, reduced ecological risks, reduced use of energy and natural resources, and reduced VOC emissions. In order to assess the risk to workers, the EPA risk assessment combines hazard and exposure data for individual chemical components of the substitute as well as the baseline products into a single qualitative expression of risk. This qualitative expression of risk provides the basis for comparing the relative worker exposure risks associated with the use of the substitute blanket wash products as compared with the baseline. While members of the general public are also potentially at risk from blanket wash chemicals that are released to air and water, the EPA risk assessment identified no concerns for the general

public through ambient air, drinking water, or fish ingestion. Due to data limitations, the exposure assessment does not estimate cumulative exposures from landfill releases or septic system releases. The relative risks of fire and explosion are determined by comparing the flash point of each blanket wash, using the OSHA definition of a flammable liquid as well as EPA's definition of an ignitable waste as a benchmark. In addition to the risks faced by workers and the general public, the risk assessment considers the potential ecological risks of using each of the alternative products and the baseline blanket wash. Several of the substitute formulations were found to present a risk to aquatic species. The energy and natural resource requirements of the substitute and the baseline blanket wash vary and a full life-cycle assessment, which was beyond the scope of this CTSA, would be needed to determine the requirements. The risks associated with volatile organic compound (VOC) releases were not examined within the risk assessment; however, the relative VOC contents of the substitute formulations are discussed below since VOC releases are the primary driving factor behind current regulations affecting printers.

### Reduced Worker Health Risks

Reduced risks to workers can be considered both a private and an external benefit. Private worker benefits include reductions in worker sick days and reductions in health insurance costs to the printer. External worker benefits include reductions in medical costs to workers as well as reductions in pain and suffering associated with work related illnesses. The EPA risk assessment considers two paths of worker exposure: inhalation and dermal. Inhalation exposure results from the volatilization of blanket wash chemicals from the blanket during washing and from the rags used to wipe down the blanket. Dermal exposure results from direct contact with the blanket wash chemicals during blanket cleaning. Worker dermal exposure to all products can be easily minimized by using proper protective equipment such as gloves or barrier creams during blanket cleaning. Worker health risks associated with the use of any blanket wash product are a function of both the product's toxicity as well as the degree of worker exposure which occurs during blanket cleaning. For example, the worker health risks associated with the use of a more toxic blanket wash may be reduced by the product's low volatility (i.e., reduced inhalation exposure) or workplace practices such as the use of automatic blanket cleaning technology (i.e., reduced dermal exposure). The exposure assessment (Chapter 3) estimates worker exposure (dermal and inhalation) for each of the blanket wash products. The risk assessment (Chapter 3) evaluates the toxicity of the individual blanket wash components for the substitute and baseline products and integrates the hazard and exposure information into a single qualitative expression of risk. The risk assessment does not provide a single measure of risk for the products overall, making it difficult in some cases to determine the relative risk from one product to another. For example, blanket wash 22 contains heavy aromatic solvent naphtha and fatty acid esters which were determined to possess moderate dermal concern and low dermal concern, respectively.

### Reduced Public Health Risk

In addition to worker exposure, members of the general public may be exposed to blanket wash chemicals due to their close physical proximity to a printing facility or due to the wide dispersion of chemicals. Such releases impose an external cost on society that is typically not considered by printing facilities in selecting their blanket wash. For example, people may breathe blanket wash vapors that have been released from a printing facility or people may drink water containing blanket wash residues discharged by a facility. Individuals in the general public that are exposed to blanket wash chemicals are therefore potentially subject to health risks. The EPA risk assessment identified no concerns for the general public through ambient air, drinking water, or fish ingestion. Using the model facility approach, the general population exposure assessment predicted that exposure levels would be extremely low for all media examined. Because of the low exposure levels, no concerns were identified for the general public from the use of blanket wash chemicals.

### Reduced Flammability Risk

Some blanket wash chemicals in this assessment present risks of fire and explosion because of their flammability and high volatility (Table 7-3). Reduced flammability risk may result in both private and external benefits. Private benefits may accrue to the printer in the form of lower risk of fire damage to the print shop. The population surrounding the print shop may experience external benefits in the form of lower risks of fire damage to their homes. In order to assess the relative fire hazard of the substitute and baseline blanket washes, the flash points of each product is compared to OSHA and EPA definitions of flammable liquids.<sup>d</sup> Flammable liquids are defined by OSHA as having a flash point less than 141°F. Similarly, EPA defines RCRA ignitable wastes (40 CFR 261.21) as having a flash point of 140°F or less. The baseline product has a flash point of 50°F, well below OSHA and EPA standards. Several of the substitute blanket washes have flash points below the OSHA and EPA thresholds: blanket washes 3, 4, 5, 8, 12, 21, 23, 24, 30, 31, 33, 34, 35, and 37.

### Reduced Ecological Risk

Blanket wash formulations are potentially damaging to terrestrial and aquatic ecosystems, resulting in external costs borne by society. The EPA risk assessment evaluated the ecological risks of the substitute products as well as the baseline blanket wash; however, only the risks to aquatic species were considered. Reductions in aquatic species risks may create external benefits by increasing the catch per unit effort for commercial fishers as well as by increasing catch and participation rates of recreational fishers. The following formulations were found to pose a risk to aquatic species: blanket washes 3, 5, 6, 8, 11, 18, and 20. All the chemicals of concern are amine salts of an alkylbenzene sulfonate. Switching to these substitutes would likely increase aquatic risks rather than decrease them. The baseline product was not identified as creating an aquatic species risk.

### Energy and Natural Resource Conservation

Benefits may accrue to society (external) as well as the printer (private) in the form of energy and natural resource savings if substitute blanket washes are substituted for the baseline wash. For example, blanket wash 34 was found to require fewer impressions to get back to acceptable print quality than with the baseline wash, thereby consuming less paper and energy. A similar situation may occur with press wipes. By switching to the substitute blanket wash, the printer might experience lower energy and resource costs. At the same time, society would also benefit from the printer's reduction in energy and natural resource use. As discussed in Section 7.1, the analysis did not estimate the individual energy and natural resource requirements of the substitute and baseline washes due to various data limitations. A thorough quantitative evaluation of each life-cycle stage was beyond the scope of the CTSA.

### Reduced Volatile Organic Compound (VOC) Releases

The reduction of volatile organic compounds (VOCs) within the pressroom can potentially result in private benefits including lower compliance costs and savings on insurance premiums, as well as external benefits including a safer work environment and reduced health effects outside

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<sup>d</sup> Flash point is defined as the lowest temperature at which a liquid gives off vapor within a test vessel in sufficient concentration to form an ignitable mixture with air near the surface of the liquid.

of the facility.<sup>e</sup> VOCs are currently regulated under clean air legislation as well as toxics use and release reporting laws and, therefore, were not re-evaluated as part of the risk assessment. Because there are several sources of VOCs within any given print shop, no attempt was made to quantify the benefits associated with an incremental reduction in the release of blanket wash VOCs. However, case studies are available documenting the potential benefits of VOC reduction throughout the pressroom. For example, the Commonwealth of Massachusetts Office of Technical Assistance found that Hampden Papers of Holyoke, Massachusetts experienced savings by reducing VOCs (97 percent reduction over a ten year period).<sup>f</sup> Hampden Papers, by adopting a source reduction strategy, has avoided the need to purchase VOC collection and control equipment or explosion-proof mixers for inks and coatings containing VOCs. In addition, they have incurred significant savings in fire insurance premiums, and reduced their liability under Superfund, air regulations, OSHA, RCRA, and other laws (OTA, no date). VOC content of the baseline as well as the alternative formulations, as measured by the GATF laboratory, are presented in Table 7-4. VOC content ranges from a low of 2 percent to a high of 99 percent. The baseline product and blanket wash 31 have the highest VOC content (99%).

### 7.2.4 Associated Costs

In comparing the cost data for the alternative and the baseline products, the costs of using the alternative blanket cleaners exceed the cost of using the baseline product in nearly all cases. Some cases required smaller quantities of wash or less cleaning time, resulting in a cost savings when using the substitute instead of the baseline wash. Blanket Washes 26, 32, 37, and 40 resulted in costs savings relative to the baseline product. Overall, however, the costs of using the substitute blanket washes exceed the costs of using the baseline wash in the large majority of cases. Costs of the using the substitute blanket washes range from a low of \$1.72 to a high of \$8.80 per press.<sup>g</sup> Costs of using the baseline product range from \$1.64 to \$3.64 per press. Where costs of the alternative blanket washes exceed the baseline, percentage cost increases range from one percent to 179 percent.

### 7.2.5 Costs and Benefits by Formulation

The objective of a social benefit/cost assessment is to identify those products or decisions that maximize net benefits. Ideally, the analysis would quantify the social benefits and costs of using the substitute and baseline blanket wash products in terms of a single comparable unit (i.e., dollars) and calculate the net benefits of using the substitute instead of the baseline product. Due to data limitations, however, the analysis presents a qualitative description of the risks associated with each product compared to the baseline. Table 7-8 compares the relative risks and costs of each substitute blanket wash to the baseline. While this table presents a comparison between the blanket washes and the substitutes, it is important to keep in mind that not all of the risk assessments are based on risk (comprised of both exposure and hazard), but that some of the assessments are based solely on a hazard call based upon a structure-activity analysis. A frowning face (☹) indicates an increase in cost, worker health risks, flammability, risk to aquatic species,

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<sup>e</sup> A successful VOC reduction strategy can not be limited to blanket washes. All sources of VOC releases (i.e., inks, coatings, etc.) within the print shop must be evaluated in order to design and implement an efficient emissions control plan.

<sup>f</sup> For a copy or further information about this case study, contact: Office of Technical Assistance (OTA), Executive Office of Environmental Affairs, 100 Cambridge Street, Boston, Massachusetts 02202, or phone OTA at (617) 727-3260.

<sup>g</sup> Presses are assumed to have four units; therefore, four blankets are washed each time a press is cleaned.

or VOC content when using the substitute blanket wash instead of the baseline product. A smiling face (☺) indicates a reduction in cost, worker risk, flammability, aquatic species risk, or VOC content when using the substitute instead of the baseline product. A zero (○) indicates that the risk assessment identified no difference in relative risks when using the substitute blanket cleaner instead of the baseline. Because the risk assessment evaluated individual blanket wash components, the relative worker health risks are based upon the component that poses the highest degree of concern. For example, components of Blanket Wash 32 were determined to pose no or low concern (propylene glycol ethers) and concern (aromatic and petroleum distillate hydrocarbons); therefore, the overall dermal risk of Blanket Wash 32 is one of concern. Blanket Wash 32 is shown to have similar relative dermal risks to workers when compared to the baseline because the baseline product's component of highest concern poses concern (i.e., petroleum distillate hydrocarbons).<sup>h</sup>

In nearly every case the substitute product costs more to use than the baseline. There were several products whose use was determined to decrease dermal worker health risks; these were Blanket Washes 1, 9, 10, 14, 17, 19, 22, 23, 29, 37 and 38. Formulation 10 was found to increase costs by less than 10 percent for one of the facilities. The few products that did show evidence of reduced costs, had mixed results in terms of their relative health risks. For example, Blanket Wash 37, which was found to be less expensive to use than the baseline, was found to reduce worker dermal risks but was neutral in terms of relative inhalation risk. Blanket Washes 26 and 40 showed evidence of reduced costs; in addition, the risk assessment found that worker dermal risks were similar for both products over the baseline. In addition, while Blanket Wash 32 was less expensive than the baseline at one facility, it was found to present increased dermal and inhalation risks over the baseline. All of the substitute products had lower flash points and, therefore, reduced flammability risk when compared to the baseline. Finally, three blanket washes (6, 11, and 20) had higher aquatic risks than the baseline.

### **7.2.6 Potential Benefit of Avoiding Illness Linked to Exposure to Chemicals Commonly Used in Blanket Washing**

As mentioned above, the risk assessment did not link exposures of concern to adverse health outcomes. Data do exist, however, on the cost of avoiding or mitigating certain illnesses that are linked to exposures to blanket wash chemicals. Such cost estimates indicate potential benefits associated with switching to less toxic products. Health endpoints potentially associated with blanket wash chemicals include: eye irritation, headaches, nausea, and asthma attacks. The following discussion presents estimates of the economic costs associated with each illness. To the extent that blanket wash chemicals are not the only factor contributing toward the illnesses described, individual costs may overestimate the potential benefits to society from substituting alternative blanket cleaners; also, this is not a comprehensive list of the potential health effects of exposure to blanket washes. For instance, inks and other pressroom chemicals may also contribute toward adverse worker health effects. The following discussion focuses on the external benefits of reductions in illness: reductions in worker medical costs as well as reductions in pain and suffering related to worker illness. However, private benefits, accrued by the decision-maker, may be incurred through increased worker productivity and a reduction in liability and health care insurance costs. While reductions in insurance premiums as a result of pollution prevention are not currently widespread, the opportunity exists for changes in the future.

Often adverse health effects are experienced when working with chemicals. For example, press operators at facility 12 experienced nausea and dizziness when using blanket wash 20, a petroleum based blanket wash containing petroleum distillates and aromatic hydrocarbons. In

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<sup>h</sup> The risk classification scheme should be interpreted as follows: no/low concern < low to moderate concern < concern.

## CHAPTER 7: EVALUATING TRADE-OFF ISSUES

Table 7-8. Relative Benefits and Costs of Substitute Versus Baseline Blanket Wash <sup>1</sup>

Formula Number	Cost/Press		Worker Health Risk		Flammability Risk	Risk to Aquatic Species	VOC Content <sup>2</sup>
	Facility #1	Facility #2	Dermal	Inhalation			
1	☹	☹	☹ <sup>3</sup>	○ <sup>3</sup>	☺	○	☺
3	Not tested		○	☹	☺	☹	☺
4	Not tested		○	○	☺	☹	☺
5	Not tested		○	○	☺	☹	☺
6	☹	☹	○	○	☺	☹	☺
7	Not tested		○	○	☺	☹	☺
8	Not tested		○	○	☺	☹	☺
9	☹	☹	☺	○	☺	☹	☺
10	☹	☹	☹ <sup>3</sup>	○	☺	○	☺
11	☹	☹	○	○	☺	☹	☺
12	☹	☹	○	○	☺	○	☺
14	☹	☹	☹ <sup>3</sup>	○	☺	○	☺
16	Not tested		○	○	☺	○	○
17	Not tested		☺	○	☺	☹	☺
18	Not tested		○	○	☺	☹	☺
19	☹	☹	☹ <sup>3</sup>	○	☺	○	☺
20	☹	☹	○	○	☺	☹	☺
21	☹	☹	○	○	☺	○	☺
22	☹	☹	☹ <sup>3</sup>	○	☺	○	NM
23	Not tested		☺	○	☺	○	☺
24	☹	☹	○	○	☺	☹	☺
25	Not tested		○	○	☺	○	☺
26	☹	☺	○	○	☺	○	☺
27	Not tested		○	○	☺	○	○
29	☹	☹	☺	○	☺	○	☺
30	☹	☹	○	○	☺	○	☺
31	☹	☹	○	○	☺	○	○

## 7.2 QUALITATIVE DISCUSSION OF BENEFIT/COST ANALYSIS

Formula Number	Cost/Press		Worker Health Risk		Flammability Risk	Risk to Aquatic Species	VOC Content <sup>2</sup>
	Facility #1	Facility #2	Dermal	Inhalation			
32	☹	☺	☹	☹	☺	○	○
33	Not tested		○	○	☺	○	☺
34	☹	☹	○	○	☺	○	☺
35	Not tested		○	○	☺	○	○
36	Not tested		○	○	☺	○	☺
37	☺	☺	○	○	☺	○	☺
38	☹	☹	☺	○	☺	○	☺
39	☹	☹	☺	○	☺	○	☺
40	☹	☺	○	○	☺	☹	☺

<sup>1</sup> Baseline Blanket Wash is Formulation 28, VM&P naphtha. Information used to develop this table varies in the level of confidence. Please refer to earlier tables and to the development of each type of information for additional information.

<sup>2</sup> "NM" indicates that VOC content was not measured.

<sup>3</sup> Level of concern for this substitute blanket wash based upon a structure-activity analysis of potential hazard.

addition, blanket wash 20 aggravated a previously existing respiratory condition in one press operator. The economic literature provides estimates of the costs associated with eye irritation, headaches, nausea, and asthma attacks, each of which may result from exposure to blanket wash chemicals. An analysis summarizing the existing literature on the costs of illness estimates individual willingness-to-pay to avoid certain acute effects for one symptom day (Unsworth and Neumann, 1993). The estimates for eye irritation, headaches, nausea, and asthma attacks are all based upon a survey approach designed to illicit estimates of individual willingness-to-pay to avoid a given illness. Such surveys, when properly designed, should capture direct treatment costs, indirect costs, and costs associated with pain and suffering.<sup>i</sup> As eye irritation, headaches, nausea, and asthma attacks typically occur as short-term, discrete incidents, cost estimates represent an individual's willingness-to-pay to avoid a single incidence and not the average lifetime cost of treating a disease. Table 7-6 presents a summary of the low, mid-range, and high estimates of individual willingness-to-pay to avoid each of these health endpoints. These estimates provide an indication of the benefit per affected individual that would accrue to society if switching to a substitute blanket wash product reduced the incidence of eye irritation, headaches, nausea, and asthma attacks.

<sup>i</sup> Several approaches are available for estimating the costs of illness. Appendix E provides a brief description of each.



**Table 7-9. Estimated Willingness-to-pay to Avoid Morbidity Effects  
for One Symptom Day (1995 dollars)**

Health Endpoint	Low (\$)	Mid-Range (\$)	High (\$)
Eye Irritation <sup>1</sup>	20.79	20.79	46.14
Headache <sup>2</sup>	1.67	13.23	66.72
Nausea <sup>1</sup>	29.11	29.11	83.66
Asthma Attack <sup>3</sup>	15.62	42.96	71.16

Sources:

<sup>1</sup> Tolley, G.S., et al. 1986. *Valuation of Reductions in Human Health Symptoms and Risks*. University of Chicago. Final Report for the U.S. EPA. January. As cited in Unsworth, Robert E. and James E. Neumann, Industrial Economics, Incorporated, Memorandum to Jim DeMocker, Office of Policy Analysis and Review, *Review of Existing Value of Morbidity Avoidance Estimates: Draft Valuation Document*. September 30, 1993.

<sup>2</sup> Dickie, M., et al. 1987. *Improving Accuracy and Reducing Costs of Environmental Benefit Assessments*. U.S. EPA, Washington, DC, September, and Tolley, G.S., et al. 1986. *Valuation of Reductions in Human Health Symptoms and Risks*. University of Chicago. Final Report for the U.S. EPA. January. As cited in Unsworth, Robert E. and James E. Neumann, Industrial Economics, Incorporated, Memorandum to Jim DeMocker, Office of Policy Analysis and Review, *Review of Existing Value of Morbidity Avoidance Estimates: Draft Valuation Document*. September 30, 1993.

<sup>3</sup> Rowe, R.D. and L.G. Chestnut. 1986. *Oxidants and Asthmatics in Los Angeles: A Benefit Analysis*. Energy and Resource Consultants, Inc. Report to U.S. EPA, Office of Policy Analysis, EPA-230-07-85-010. Washington, DC March 1985. Addendum March 1986. As cited in Unsworth, Robert E. and James E. Neumann, Industrial Economics, Incorporated, Memorandum to Jim DeMocker, Office of Policy Analysis and Review, *Review of Existing Value of Morbidity Avoidance Estimates: Draft Valuation Document*. September 30, 1993.

### **7.3 OVERVIEW OF RISK, COST AND PERFORMANCE**

This section gives an overview of the substitute blanket washes including information regarding performance, cost, risk and exposure, and regulatory concerns. Since these evaluation factors are unique to each formulation, an individual profile was developed for each of the substitute blanket washes. The results of the process safety and general population risk analyses are similar for all formulations (see Sections 3.5 and 3.4.4, respectively). The profile summarizes information from various sections of the CTSA as described below.

#### Chemical Information

The generic chemical composition of each substitute blanket wash is provided. The categorization of blanket wash chemicals used to genericize the formulations was described in detail in Section 2.1. Also included in each profile are the flash point, VOC content, and pH of each substitute wash, which were determined during laboratory testing by the Graphic Arts Technical Foundation (GATF) (see also Table 4-1).

#### Performance

The performance section of the profile summarizes information collected during laboratory and production run performance demonstrations with each substitute blanket wash. The data on